A GUIDE FOR ESTIMATING THE EFFECTS CURRENT LIVESTOCK MANAGEMENT HAS ON STREAM FISH PRODUCTION

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I. Introduction.

This guide is designed to assist range management specialists in analyzing the condition of the riparian environment in relation to the past and current livestock grazing management and the compatibility of the grazing with associated aquatic resources. The major limiting factor for fish production in many streams is lack of good quality pools and other cover that is essential for overwintering juvenile and adult fish. On low gradient meadow streams, the primary fish cover is provided by overhanging vegetation and undercut banks. Therefore, excessive removal of the vegetation and trampling of the bank by livestock can reduce the ability of those streams to support fish.

This guide is not intended to replace presently used stream surveys or fish population analyse. Rather it uses existing information to derive an initial indication of how livestock grazing may be affecting fish populations.

The guide provides a site description for the fisheries biologist who may not be familiar with the site, but who will evaluate the data later to make management recommendations. It also provides a rating criteria for the observer to collect basic information for running the model. The rating criteria are designed so that no field equipment is necessary for collecting the information. The model predicts the effects the past and present grazing system may have on the fisheries environment. This information can then be used for discussing allotment management with the permittee.

This method can be used to evaluate a single site or by obtaining a number of samples the method can evaluate a large area. Data from five sites per stream mile would be needed to provide a 10 percent sampling of the study area. A stream with diverse habitat may require a larger number of samples.

II. Discussion.

This methodology uses several habitat criteria that can be evaluated in the field to provide the necessary data for implementing the fishery model.

The vegetative type along the stream dictates the quantity of grazing the riparian zone can sustain before impacts to the fishery habitat are expected to occur. Streams which primarily support grasses and forbs along the banks are most vulnerable to livestock damage because of vegetative removal and mechanical damage to the banks. As the percentage of willows and other woody vegetation increases within the

streambank vegetative composition, protection to the banks and bank vegetation increases. The vegetative type least susceptible to livestock damage is willow/conifer where heavy, woody vegetation provides a considerable amount of protection to the forage plants. Also, bank cover is not as critical to the well-being of the aquatic environment because a larger percentage of instream cover is provided by large debris and rocks.

The landform gradient can influence livestock use in the streambottoms. Steep landform gradients result in abrupt changes in vegetation which, along with the physical nature of the terrain, can encourage livestock to remain in the riparian zone.

The width/depth (W/D) ratio is a comparison of stream width to depth. Deep, narrow channels are more conducive to trout production than are streams with wider, shallower profiles. This is particularly important for those streams subject to severe climatic conditions. Excessive livestock use within the stream channel can break down the banks which eventually leads to wider and shallower profiles.

Vast reductions in number of native trout have occurred in many western streams from loss of undercut banks. Preferred bank conditions are often associated with heavy root masses and dense vigorous vegetative growth. Preferred undercut banks have a bank angle of 90 degrees or less. Therefore, cover provided by undercut banks and overhanging vegetation helps to determine fish biomass in the stream environment. Stream cover of this type is more important to the well-being of a fishery in a low gradient stream meandering through a meadow than it is for a higher gradient stream that has other forms of cover. The higher the dependency fish production has on bank cover, the more it can be influenced by livestock grazing.

Excessive fine sediment within the streambed (1/8 inch diameter, or less) can choke out developing fish eggs and fry as well as decrease aquatic invertebrate development. Embeddedness (filling in of the spaces between gravel, rubble and boulders with fine sediment) reduces the habitat's ability to overwinter fry and fingerlings. Fine material deposits first in the pools, but as the sedimentation rate increases, accumulation will also occur in the riffle areas. This evaluation is to provide an estimate of fine material throughout the entire streambottom regardless of pool/riffle composition.

The guide is based on the percentage of riparian forage utilized by livestock because forage removal is related to the amount of effective banks cover no longer available. Identification of this percentage is important when making recommendations for the improvement in management of the allotment.

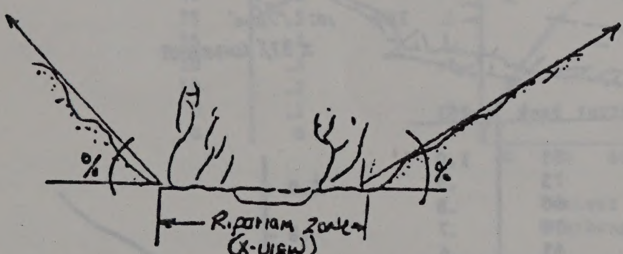
Stream gradient can also be an indicator of stream productivity. Steeper streams (in excess of 5 percent) can have less of a carrying capacity for fish production compared to streams with lesser gradients. This is because of the turbulent nature of the flow which generally results in less resting, rearing and spawning areas available to the various life stage of the fish. Under extreme conditions, this can cause physical barriers to fish passage. The stream gradient can be determined by estimating the vertical change in elevation for 100 feet of stream. This vertical drop would be the stream gradient for that section expressed in percent.

III. Data Collection.

A. Site Description for Table 1.

1. Determine the vegetative type by percent for the site being analyzed. This pertains only to the vegetation within the riparian zone along the stream corridor.

2. The side valley slope gradient describes the change in gradient (in percentage) from the outside edge of the riparian zone to the immediate adjoining terrain on both sides of the stream.



3. Record the percentage of each type of cover that occur along the streamside.

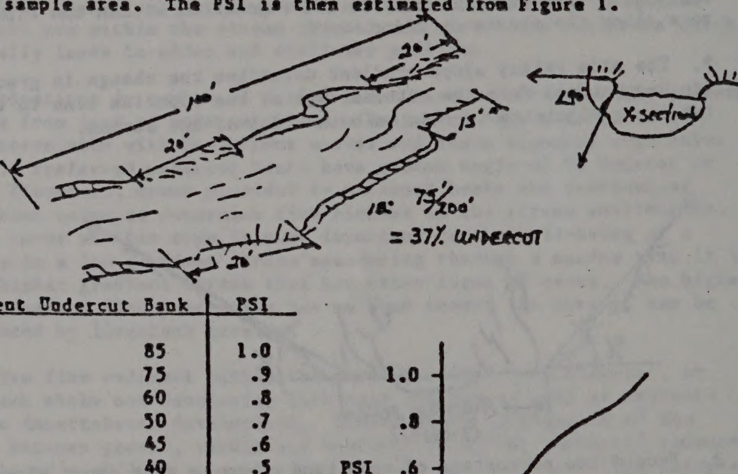
4. The width/depth (W/D) ratio describes how wide the stream is compared to its depth. Stream depths can be determined by using a stick or branch and estimating the water depth at 1/4, 1/2, and 3/4 distance across the stream. Total these three depths, divide by 4 and round off to the nearest 1/2 foot. The mean stream width is also estimated. The W/D ratio is determined by dividing the mean width by the mean depth. If, for an example, the stream is 10 feet wide and one foot deep, the W/D ratio would be 10/1 or 10.

5. The forage utilized refers to the amount of grass and forbs that have been grazed during the past grazing season. It is measured by weight and pertains only to the riparian zone (a minimum of 100 linear feet on each side of the stream).

B. Rating Criteria.

The rating guide is composed of five variables that can indicate livestock effects on streams. The field value obtained for each variable is converted to a parameter suitability index (PSI) based upon principles similar to that developed by the U.S. Fish and Wildlife Service in their habitat suitability index models. The five PSI values are then averaged to obtain a habitat suitability index (HSI) that is then used to compare existing stream habitat conditions with its potential.

1. Estimate the percentage of undercut banks occurring over the 100 foot sample area. The PSI is then estimated from Figure 1.



Percent Undercut Bank	PSI
85	1.0
75	.9
60	.8
50	.7
45	.6
40	.5
35	.4
30	.3
25	.2
10	.1
0	0

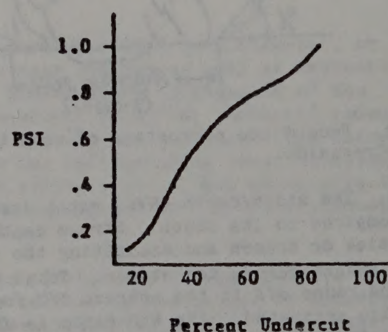
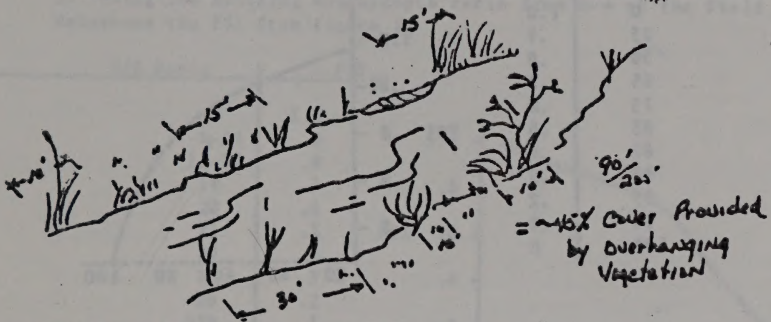


Figure 1

2. The percent of bank supporting vegetative overhang at the end of the grazing season is determined. This includes only vegetation that is left tall enough to provide overhanging cover to the stream. Use Figure 2 to determine the PSI for this relationship.



Percentage Vegetation Overhang	PSI_2
100	1.0
75	.9
55	.8
45	.7
40	.6
35	.5
25	.4
20	.3
10	.2
0.	.1
0	0

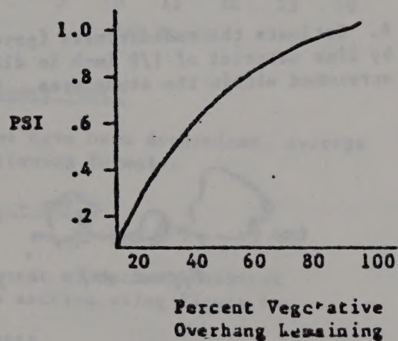
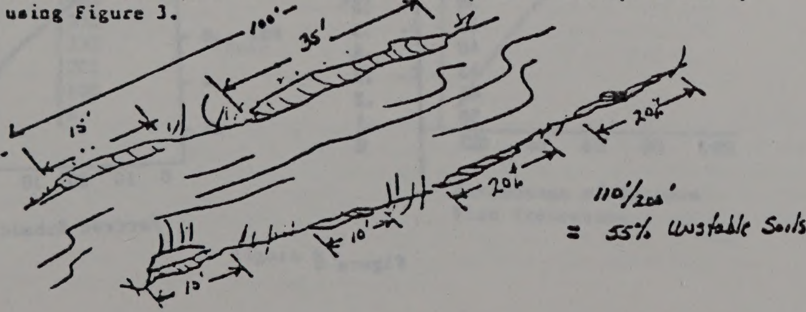
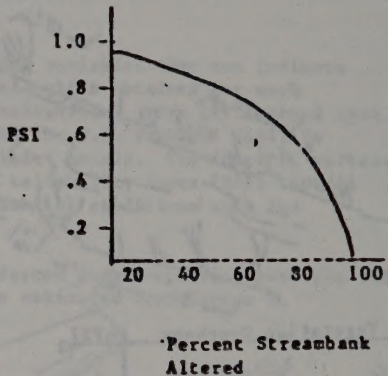


Figure 2

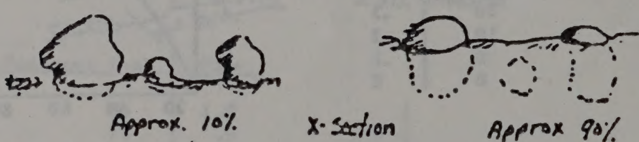
3. The streambank soil alteration rating estimates the stability of both streambanks. Estimate the percentage of the streambank where soils are exposed or being trampled. Once the percentage is determined, convert it to the PSI as completed in Steps 1 and 2, using Figure 3.



rcentage Streambank Altered	PSI_3
0	1.0
25	.9
50	.8
65	.7
75	.6
85	.5
88	.4
90	.3
95	.2
98	.1
100	0



4. Estimate the embeddedness (percent coverage of bottom substrate by fine material of 1/8 inch in diameter or less) over the entire streambed within the study area. Determine the PSI using Figure 4.



Percent Embeddedness	PSI_4
0	1.0
10	.9
20	.8
25	.7
30	.6
35	.5
40	.4
43	.3
46	.2
50	.1
55	0

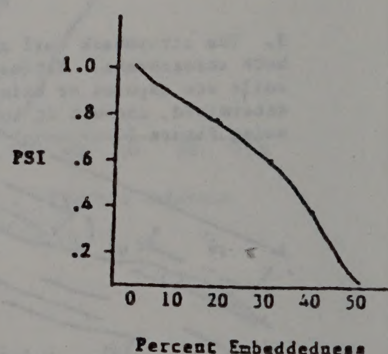


Figure 4

5. Using the existing width/depth ratio from A-4 of the Field Form, determine the PSI from Figure 5.

W/D Ratio	PSI_5
<5	1.0
6-12	.9
13-18	.8
19	.7
20	.6
21	.5
23	.4
25	.3
26	.2
>26	.1

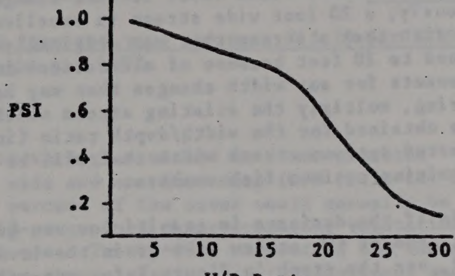


Figure 5

C. Determining the Habitat Suitability Index (HSI)

Once the parameter suitability indices have been determined, average them to obtain a mean value using the following formula:

$$\frac{PSI_1 + PSI_2 + PSI_3 + PSI_4 + PSI_5}{5}$$

Once this is completed, determine the percent of optimum (habitat suitability index, or HSI) for the stream section using Figure 6.

Mean PSI	Percentage of Optimum (HSI)	
1.0	100%	Excellent
.9	75%	Good
.8	65%	
.7	55%	Fair
.6	45%	Mean
.5	40%	
.4	35%	
.3	25%	Poor
.2	20%	
.1	10%	
0	0	

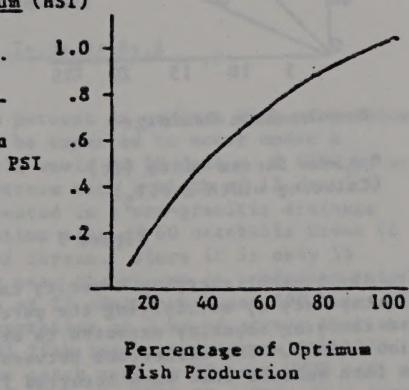
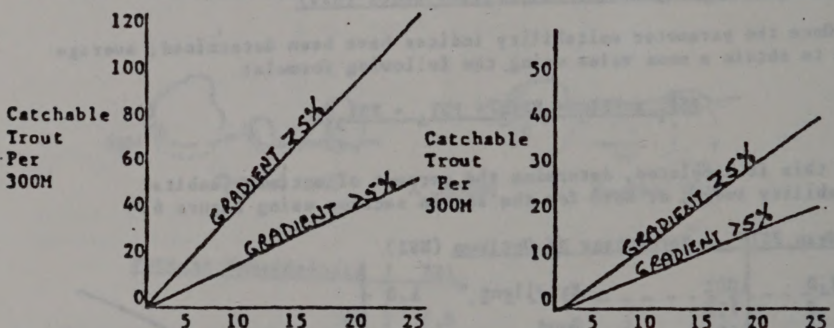


Figure 6

D. Determining the Maximum Fish Carrying Capacities

It is necessary to determine the fish carrying capacity that would occur under optimum stream conditions so that any tradeoffs in fish production that may be occurring under current livestock management can be identified. When using Figure 7, it is necessary to use the optimum stream width that would occur if bank damage was not occurring. Obviously, a 20 foot wide stream in excellent condition will support more fish than a stream that was originally 10 foot wide, but has widened to 20 feet because of alterations in the stream profile. To compensate for any width changes that may have occurred from grazing or scouring, multiply the existing stream width (from A_6) times the PSI value obtained for the width/depth ratio (in B_5). This will be the estimated optimum stream width that will be used in Figure 7 for determining optimum fish numbers.

Decide if the drainage is granitic or non-granitic in origin. If in doubt, and if the stream area is in the lower elevations (6000 feet or less), use the graph in Figure 7 for non-granitic. Use the appropriate slope in Figure 7 that corresponds with the stream gradient estimated in A_6.



-Non-Granitic Drainage-

Optimum Stream width (ft)
(Existing width x PSI_5)

-Granitic Drainage-

Optimum stream width (ft)
(Existing width x PSI_5)

Figure 7

Finally, the present carrying capacity can be compared to the potential carrying capacity by multiplying the percent of optimum (C-2) times the expected carrying capacity expected to occur under optimum habitat conditions (C-3). The difference between the two would be the estimated loss in fish numbers that have occurred from present management.

E. Determining an Economical Value.

The monetary value of the fishery is determined using Wildlife and Fish User Days (WFUDs). The average angler catches 0.5 fish per hour and a WFUD is 12 hours, therefore six fish would equal one WFUD. A WFUD has a \$15.75 value. The following equation determines the annual fishery value loss per allotment in dollars:

$$\frac{\text{Km of stream in allotment} \times \text{fish loss per year per km} \times \$15.75 \text{ per WFUD}}{\text{Six fish caught per WFUD}}$$

F. Example.

For example, a stream flowing through a meadow in a non-granitic watershed, is presently 20 feet wide and one foot deep (W/D ratio=20) on the site being analyzed. Fifty percent of the cover would normally be provided by undercut banks and 60 percent of the overhanging vegetation is remaining following livestock use. Twenty-five percent of the banks are trampled and show damage. The stream gradient is three percent and the embeddedness is estimated to be 30% along the stream bottom. Using the appropriate figures, the following PSI values are obtained:

1. Fifty percent undercut banks = PSI_1 of .7.

2. Sixty percent of the vegetation cover remaining = PSI_2 of .8.

3. Twenty-five percent of the stream banks are altered = PSI_3 of .9.

4. Embeddedness of the stream bottom is 30 percent PSI_4 of .6.

5. The current width/depth ratio is 20 = PSI_5 of .6. The mean PSI is figured by averaging the PSI values:

$$\frac{PSI_1 + PSI_2 + PSI_3 + PSI_4 + PSI_5}{n} = \frac{.7+.9+.9+.6+.6}{5} = .7$$

Using Figure 6, this converts to 55 percent or maximum fish production. The optimum stream width that would be expected to occur under a non-grazing situation in this example would be 20 feet x .6 (PSI_5), or 12 feet. Referencing Figure 7, a stream with a width of 12 feet, a gradient less than 5 percent and located in a non-granitic drainage would have an estimated fish population size of 60 catchable trout (6 inches or greater) per 300 meters of stream. Since it is only 55 percent of maximum due to livestock use, the stream is producing only 33 catchables per 300 meters or a loss of 27 adult trout per 300 meters (90 per km). If this sample was representative of 3 km of stream that was within the allotment, then the total fish loss per year would be 270 trout. Based upon 0.5 fish per hour catch rate, a 12 hour WFUD and \$15.75 per WFUD, this converts to 45 WFUDs or \$709.00. This is a loss of \$14,175, plus interest, over a 20 year period-the life expectancy of most range and wildlife improvement projects.

This information can be readily obtained in the field to enable range specialists to immediately know what the current grazing use is doing to the stream and to the fisheries. It demonstrates if a problem exists and what the trade-offs are. The District Ranger can then decide if changes in grazing methods for that particular allotment are needed. It also highlights areas where District personnel should consult with a fisheries biologist.

FIELD FORM

Map Unit ____________

Allotment ____________ Number ________ Forest ____________ District ________

Range Type(s) ____________ Pasture ________ No. ______ Elevation ________

Livestock Class ____

Range Type ____________ Range Suitability ____________ Slope Class ________

Season of Use ____________________ Grazing System ____________________

Location 1/4 Section ____________________ Township ____________ Range ________

Stream ____ Date ____________

Observer(s) ____

A. Site Description

1. Riparian Habitat Type — Percent

    ________ grass/forbs
    ________ sedges
    ________ grass/willow (< or = 50% willow)
    ________ grass/willow (>50% willow)
    ________ willow/conifer
    ________ other (specify)

2. Side valley slope gradient of riparian zone

    Left Bank ____________% Right Bank ____________%

3. Dominant streamside cover (percent)

a. palatable shrubs	______	______
b. unpalatable shrubs	______	______
c. tree form	______	______
d. grass/forb	______	______
e. >50% soil, rock	______	______

4. Determine the average stream width and depth and then select the appropriate width/depth ratio (refer to A-4 of instructions).

    Stream Width ________

    Stream Depth ________

    Width/Depth Ratio ________

5. Percent forage utilization in riparian zone. ________%

Note: Left and right bank is determined facing downstream.

6. Record the stream gradient in percent. ____________%

B. Rating Criteria.

	%	PSI
1. Percent Streambank undercut. (Refer to B-1 of instructions).	______%	______
2. Percent vegetative cover overhang (grass/forbs) remaining by volume. (Refer to B-2 of instructions).	______%	______
3. Streambank soil alternation rating. Show the percentage of each bank that is actually eroding or showing mechanical damage, vegetative cover removal or other forms of stress. (Refer to B-3 of instructions).	______%	______
4. Percent of bottom substrate covered with fine sediment (less than 1/8 inches in diameter). (Refer to B-4 of instructions).	______%	______
5. Enter the current width/depth ratio for this stream site from A-4. (Refer to B-5 of instructions). W/D =	______%	______

C. Calculations:

1. Enter the Habitat Suitability Index (HSI) from III-C of instructions.__________

2. Enter the percent of habitat optimum (Fig. 6 of Instructions).__________

3. Determine the maximum fish carrying capacity (from III-D of Instructions).__________

4. Determine fish production under current conditions (multiply C-? X C-3).__________

5. Enter fish loss in: Numbers (C-3 - C-4)__________
WFUDS (III-E of Instructions)__________
Dollars (III-E of Instructions)__________

Observer's evaluation of riparian habitat trend and cause of any degrading or improving riparian habitat conditions.

Observer's comments on solutions to any degradation problem:

Remarks (diversions, crossings, trailing areas, etc.)

5. Record the stream gradient in percent. ______________%

B. Rating Criteria.

	I	III
1. Percent streambank [illegible]. (Refer to B-1 of instructions).		
2. Percent vegetative cover overhang (grass/forbs) remaining by volume. (Refer to B-2 of instructions).	______%	______
3. Streambank soil alteration rating. Show the percentage of each bank that is actually eroding or showing mechanical damage, vegetative cover removal or other forms of stress. (Refer to B-3 of instructions).	______%	______
4. Percent of bottom substrate covered with fine sediment (less than 1/8 inches in diameter). (Refer to B-4 of instructions).	______%	______
5. Enter the current width/depth ratio for this stream site from A-4. (Refer to B-5 of instructions).	W/D = ______%	______

C. Calculations:

1. Enter the Habitat Suitability Index (HSI) from III-A of instructions ____________
2. Enter the percent of habitat optimum (Fig. 4 of instructions) ____________
3. Determine the maximum fish carrying capacity (from III-B of instructions). ____________
4. Determine fish production under current conditions (multiply C-2 X C-3) ____________
5. Enter fish loss in: Numbers (C-3 - C-4) ____________
   Money (III-E of instructions) ____________
   Habitat (III-F of instructions) ____________